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Carbonates of the Lower and Middle Ordovician in Central Pennsylvania

Henry S. Chafetz

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CARBONATES OF THE LOWER AND MIDDLE ORDOVICIAN IN CENTRAL PENNSYLVANIA

by
Henry S. Chafetz

ABSTRACT

This investigation concerns the petrology and stratigraphic relationships of a succession of intercalated limestone and dolomite beds at the contact between the Lower and Middle Ordovician in central Pennsylvania. This sequence, herein referred to as the Milroy Member, is situated above the youngest typical Bellefonte Dolomite, uppermost formation of the Beekmantown Group, and below the oldest typical Clover Limestone of the Loysburg Formation, lowermost formation of the rocks assigned to the Middle Ordovician. The Milroy Member ranges in thickness from 0 to 400 feet. It occurs at the stratigraphic interval occupied by the post-Beekmantown hiatus. The relationship of these beds to the disconformity is at the core of the problem of this study.

The Milroy consists almost entirely of micritic rocks. A few sparites can be found in the section, but they are uncommon. The three most abundant rock types are: intramicrites, with the clasts composed of either torn-up algal mats or micrite; algal mat biomicrites, containing either continuous or disrupted algal mats; and micrites.

The petrographic analysis of the Milroy Member indicates that this unit was deposited in a very shallow marine to intertidal to supratidal environment. The algal laminations are commonly found to have been disrupted by burrows, desiccation cracks and clasts torn loose by water turbulence.

The upper and lower contacts of the Milroy Member appear to be gradational with the adjacent units. The dolomite beds in this transition zone cannot be differentiated from those in the Bellefonte Dolomite. Likewise, the limestone beds in the Milroy and the Clover Limestone are very similar. Faunal diversity in the Milroy increases upward gradationally into the overlying Clover Limestone. The writer believes that the Milroy Member, where present, represents continuous deposition between the Lower Ordovician Bellefonte Dolomite and the Middle Ordovician Clover Limestone.

INTRODUCTION

SCOPE

The purpose of this investigation was to determine the relationship between the Lower and Middle Ordovician strata of central Pennsylvania. The boundary between these series is placed at an unconformity of craton-wide dimensions, the Sauk-Tippecanoe sequence boundary of Sloss (1963). A widespread unconformity has been observed at this stratigraphic position over most of the Appalachians (Butts, 1926, 1939; Butts and Moore, 1936; Cooper and Prouty, 1943; Cooper, 1944; Butts and Gildersleeve, 1948; Prouty, 1946, 1948; Wilson, 1948, 1949; Bridge, 1950, 1955; Munyan, 1951; Kellberg and Grant, 1956; and King and

Ferguson, 1960). A succession of intercalated limestone and dolomite beds up to 400 feet thick occur above the Lower-Middle Ordovician boundary in Pennsylvania. This unit is the Milroy Member of the Loysburg Formation (Rones, 1955). The beds are transitional in their compositional relationship to the dolomite beds of the underlying Bellefonte Formation and the limestone beds of the overlying Clover Member of the Loysburg Formation. I believe that the Milroy represents continuous accumulation across this interval and therefore the unconformity does not exist where the Milroy is present. In his study of the Cambrian and Ordovician of central and western Pennsylvania, Wagner (1966) independently came to basically the same conclusion. He states that "The Lower Ordovician strata in central Pennsylvania grade upward into those of the Middle Ordovician." For a regional description of the stratigraphy and paleogeography the reader is referred to Wagner (1966).

Data gathered by C. E. Prouty established the fact that the lithologies of the formations immediately above and below the boundary between the Lower and Middle Ordovician change laterally, especially east of the Adirondack arch in Pennsylvania. For this reason the purpose of this study was best served by restricting the area of investigation to that defined below where units subjacent and superjacent to the Milroy could be readily identified.

The Beekmantown Group forms most of the Lower Ordovician in central Pennsylvania. In this area the uppermost unit is the Bellefonte Dolomite, a dense, massive dolomite approximately 2,000 feet thick.

The Chazyan Series (early Middle Ordovician) is predominantly limestone. The lowermost Chazyan is the Loysburg Formation. Kay (1944) divided the Loysburg Formation into two members, the Clover Limestone Member above and the Tiger-striped Member below. In this paper the interval previously designated as the Tiger-striped Member (Kay, 1944), the Milroy Member (Rones, 1955, 1969), or the transition beds (Chafetz, 1967) will be referred to as the Milroy Member of the Loysburg Formation. The Milroy ranges in thickness from 0 to 400 feet. It consists of a series of intercalated limestone and dolomite beds of varying thicknesses, exhibiting megascopic characteristics similar to the overlying Chazyan and the underlying Beekmantown.

LOCATION OF AREA

Figure 1 is a location map of the study area in central Pennsylvania. Investigation was confined to the area bordered by the Adirondack axis on the east (coincident with Path Valley), the Pennsylvania Turnpike on the south (approximately 40° N. latitude), the Allegheny Front on the west, and approximately 41° N. latitude on the north.

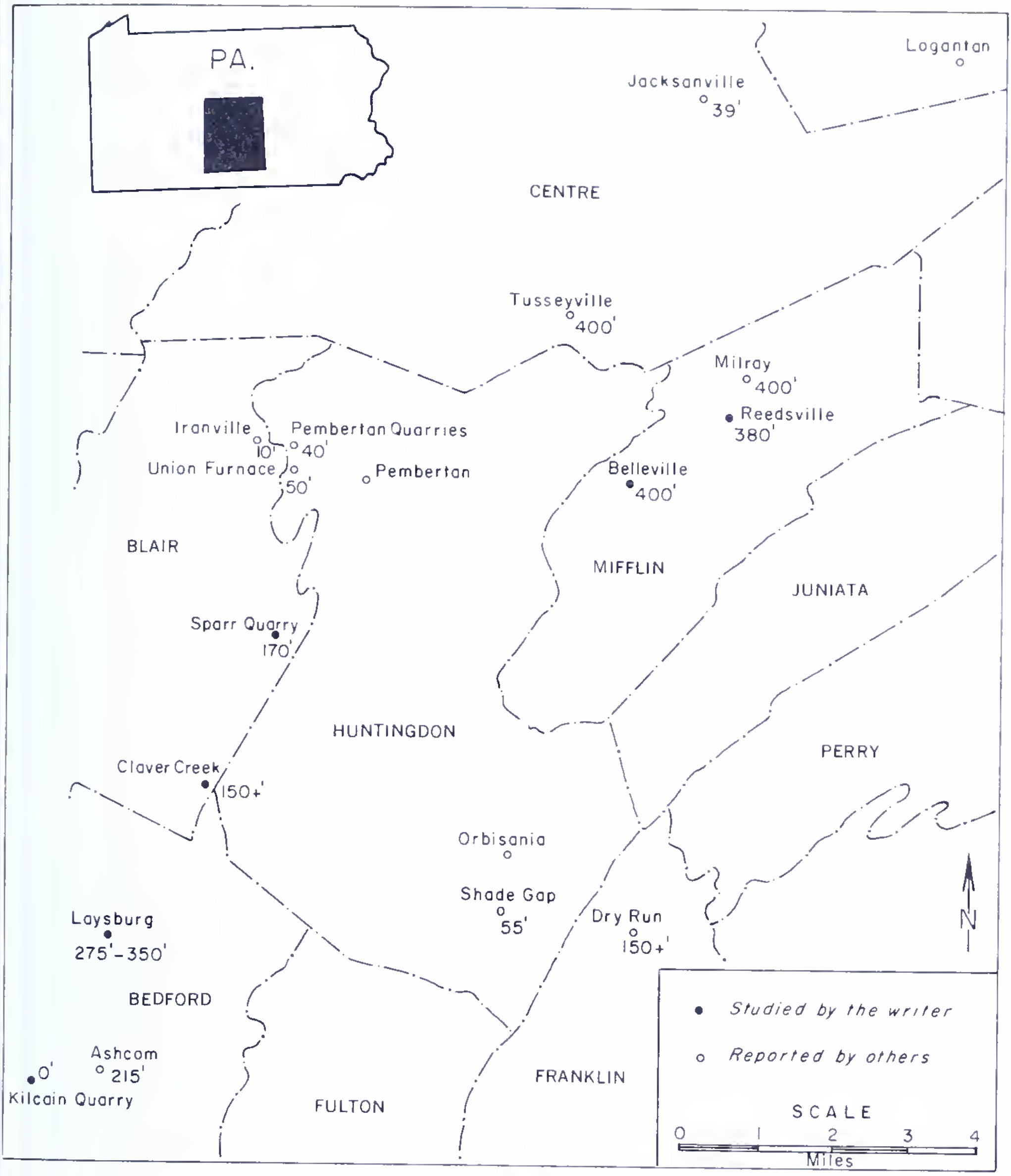


Figure 1. Index map of Milroy Member outcrops.

The locations of the sections studied are indicated on the map. Localities which exhibit strata of transitional nature referred to by other investigators are also indicated.

PREVIOUS WORK

In 1936, Butts and Moore concluded that a problem exists because "there is no sharp lithologic boundary between the Bellefonte dolomite and the Carlim limestone, but the one passes into the other through a varying thickness of dolomite, including layers of pure-blue fossiliferous limestone of Carlim type. . . ." The Carlim Formation of Butts includes

the Milroy Member in part or total, and the Clover Limestone and Hatter Formation of Figure 2. Butts (1939) described the strata beneath the Carlim Limestone as "an alternation of layers of dolomite and scantily fossiliferous blue limestone. . . ." He estimated a maximum thickness of 50 feet for these beds at an outcrop near Union Furnace, Huntingdon County, Pennsylvania.

G. Marshall Kay (1944) discussed these units in his description of rock sequences in which interbedded limestones, laminated dolomites, and occasional intraformational conglomerates underlie the Clover Member of the Loysburg Formation. Kay believed that the similar appearances of the dolomite units indicated that these traditional beds represent a conformable relationship between the subjacent upper Bellefonte Dolomite and superjacent Carlim Limestone. He described five localities at which the Milroy Member is present. Several of these are sections at which this interval exceeds 200 feet in thickness.

Rones (1955, 1969), in his study of the Middle Ordovician of central Pennsylvania, applied the manuscript name "Milroy," a village in Centre County, to these units. He estimated the maximum thickness of the Milroy to exceed 400 feet. His type section is mostly covered and neither the upper nor lower contact is exposed.

FIELD OBJECTIVE

The Milroy Member is absent from many outcrops containing rocks which range in age from Early to Middle Ordovician. No marker beds or other horizons which could be used to establish stratigraphic position were found within the transition zone. Thus it was necessary to find sections where the Milroy is in contact with either the Clover Limestone or the Bellefonte Formation. The rocks above and below the transition zone were also examined. Five localities were chosen for detailed study and are referred to as Reedsville, Belleville, Sparr Quarry, Clover Creek, and Loysburg.

ACKNOWLEDGMENTS

I am greatly indebted to Dr. C. E. Prouty, of the Department of Geology, Michigan State University, for his assistance in formulating the problem, for his guidance in the field and in the resulting investigation, and for the use of certain data gathered by him during previous field sessions.

I would like to express my gratitude to Dr. Robert L. Folk and Joseph McGowen, of the Department of Geology, University of Texas at Austin, and to Dr. Christopher G. St. C. Kendall, of the Department of Geology, University of Sydney, Sydney, Australia, for reading and making observations on the manuscript.

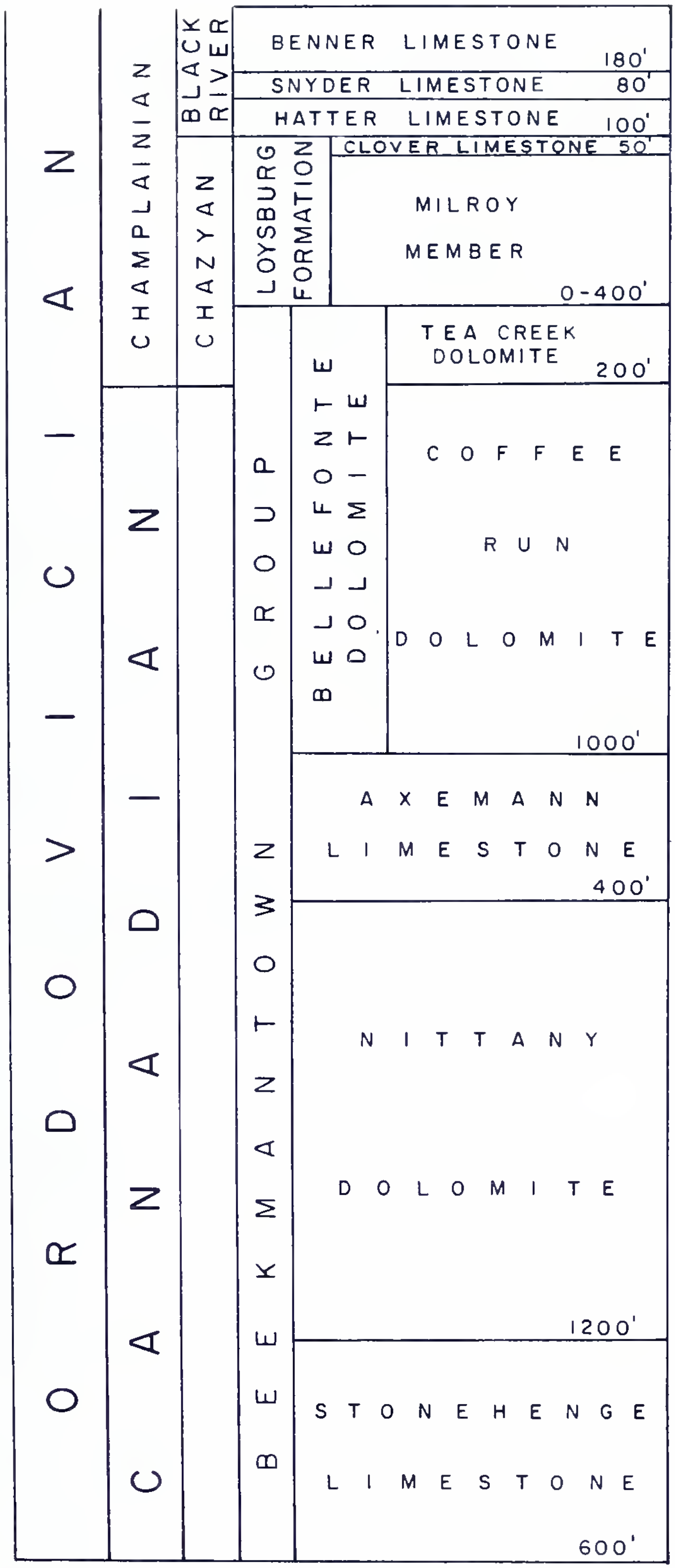


Figure 2. Generalized stratigraphic column.

STRATIGRAPHIC SUCCESSION

BELLEFONTE DOLOMITE

The uppermost formation of the Beekmantown Group (Figure 2) is the Bellefonte Dolomite. This formation is 2,145 feet thick at the town of Bellefonte in Centre County.

Rones (1955) divided the formation into the lower Coffee Run Member and the upper Tea Creek Member. In the area covered by the Bellefonte quadrangle and immediately adjacent to it a sandstone unit referred to as the Sandstone Member of the Bellefonte Dolomite by Butts and Moore (1936) exists between the lower and upper members of the Bellefonte Formation. Wagner (1966) has shown that this sandstone body is actually the higher of two, possibly three, sandstone units. Although locally absent, the sandstone has been recognized along the strike of the belt as far southwest as Wood County, West Virginia (Prouty, and others, 1959). The unit helps separate the Tea Creek and Coffee Run Members although the aphanitic Tea Creek can usually be distinguished from the more crystalline Coffee Run. The lower dolomite is approximately 1,000 feet thick; the upper sandstone unit has a maximum thickness of 12 feet; and the upper dolomite is about 200 feet thick.

The contact between the Lower and Middle Ordovician strata has been placed within the Bellefonte Formation (Wagner, 1966), stratigraphically the highest formation of the Beekmantown Group. The gross stratigraphy suggests that the upper member of the Bellefonte Formation is Chazyan in age, Middle Ordovician.

Tea Creek Member

The Tea Creek Member is an aphanitic, light brownish-gray to medium gray dolomite which fractures conchoidally.

The strata contain layers of intraclastic limestone and dolomite. The particles frequently appear to have been torn from the underlying strata while they were still in a semiconsolidated state. Intraformational breccia layers commonly occur superjacent to thinly laminated zones.

"Rosebud" (rosette) concretionary zones are present at various stratigraphic horizons. Zones of concretions are relatively abundant at the Sparr quarry locality. Each zone is usually restricted to a single bed, but concretions are occasionally seen in adjacent beds. The "buds" vary in composition, consisting of calcite, dolomite, or quartz. Almost all concretions examined are monomineralic. Likewise, each zone of rosebud concretions was also found to be essentially monomineralic. In a

few instances the growth of the buds was observed to have pushed aside the fine laminations within the beds. This suggests that the rosebud concretions formed after deposition and before lithification of the enclosing strata. The buds range in size from incipient ones, a fraction of an inch in diameter, to nearly a foot in diameter. Most of these concretions are elongate parallel to the bedding and are ellipsoidal in shape. At highly weathered outcrops the rosebuds appear as irregular cavities, as, for example, at the Reedsville section.

The only fossils found in the Tea Creek Member comprise stromatolitic layers. Here the beds are partially or entirely finely laminated. Occasionally these fine laminations can be traced along the bed to a site at which they mushroom into a "cryptozoon" head.

Another feature observed in the Tea Creek Member is a peculiar blotchy reddish-tan staining, the cause of which was not determined. The stain patterns are similar to patterns developed in a burrowed limestone. It is present in only a few units and apparently randomly distributed throughout the dolomite.

Stylolites are common; in addition, a surface of relief up to half a foot in magnitude is found between many adjacent beds. This is most noticeable at the Sparr quarry locality where the beds dip steeply. This surface feature strongly resembles the karren surfaces that develop in karst areas.

LOYSBURG FORMATION

The Loysburg Formation is divided into two units, the Milroy Member and the Clover Member.

Milroy Member

Stratigraphy

The Milroy Member does not occur as a continuous rock body throughout the area investigated. It is present only locally as lens-shaped masses. This form is suggested by the occurrence of sections varying in thickness from 0 to slightly more than 400 feet (Rones, 1955). The actual lens shape is inferred because no outcrops were found which could be followed continuously for any considerable distance.

These transitional units exhibit a gradual change from the structureless, thin-bedded (0.5 to 2 feet thick), aphanitic dolomites of the Tea Creek Member of the Bellefonte Formation to the biomicrites of the Clover Member of the Loysburg Formation.

Aphanitic dolomite beds of the Milroy Member are almost identical lithologically to the dolomite beds of the Tea Creek Member. The contact between the Milroy and the Bellefonte Formation was placed directly beneath the first occurrence of the limestone.

The Milroy Member has also been referred to as the Tiger-striped Member of the Loysburg Formation. This name is the result of the occurrence of very thin alternating ribbonlike bands of limestone and dolomite. The individual bands are usually less than an inch in thickness and make up beds up to 10 feet in thickness throughout the Milroy. Weathering yields the "tiger-striped" pattern which prompted the name by Kay (1944). The light brownish-gray dolomite bands stand out in relief against the less resistant very light gray limestone layers.

Strata in the Milroy Member of the Loysburg Formation are 1 to 2 feet thick and thin bedded (Pettijohn, 1957). Lithology ranges from dolomite to limestone; shale constitutes a very small percentage of the total thickness. The intercalation of the dolomite and limestone seems to be entirely random in distribution. Dolomite beds are finely crystalline, hard, dense rocks with a conchoidal fracture. Fresh rock is usually a light brownish gray to medium gray and weathers light brownish gray to light gray. Limestone beds are medium gray to dark gray, commonly referred to as "blue," and weather very light gray.

Stromatolitic laminations and intraformational breccias are present in the same manner and abundance as those in the Bellefonte Formation. Several rosebud zones occur in strata constituting part of the Milroy Member. Fossils, excluding the stromatolites, are commonly concentrated in layers in these transitional beds. They are most abundant in limestone beds.

Limestone of the upper Milroy Member and the Clover Limestone are similar. The boundary between these two members is placed directly beneath the first bed with an abundant and diverse fauna above which occur no dolomite beds greater than 3 feet in thickness. This faunal condition does not include ostracodes and trilobites which are well represented in the Milroy.

Lithology

Dolomite layers range in color from pinkish gray (5YR8/1) to medium gray (N5) to dark gray (N3) (Rock-Color Chart, 1963). Medium gray is the most common color. Rocks seldom are a single color within a hand specimen. Commonly a layered or mottled appearance is accentuated by color variations. Dolomite beds usually weather yellowish gray (5Y8/1) to very pale orange (10YR8/2).

The dolomite beds are hard, dense, and commonly break with a pronounced conchoidal fracture. Fine laminations are etched in relief on the weathered surfaces of many dolomite beds. This characteristic is produced by very thin zones of more resistant layers within the dolomite beds. Study of polished sections revealed the origin of the laminations to be the product of blue-green algae.

These algal-bound layers are the dominant sediment type in the section, and the majority of the beds contain at least some indication of the ubiquitous presence of algal mats. Algae, all of the blue-green variety, are present in various forms. The presence of algal structures can usually be recognized even after extensive dolomitization.

Dolomitized algal mat biomicrite (Folk, 1959, 1962) is a frequently encountered lithology. In this rock, algae occur in fairly continuous layers which are subparallel to one another and to the bedding. Individual layers typically exhibit a crenulated form. Continuity of the mat is occasionally interrupted by burrows, eruption features caused by escaping gas, desiccation cracks, clasts torn loose by water turbulence, and other such phenomena whose agencies are as yet unrecognized.

Algal mats occur in many places as dolomitized disturbed algal mat biomicrite. This genetic, rather than descriptive, terminology calls attention to a sediment type very similar to the one discussed immediately above. Disturbed algal-mat biomicrite is a torn-up algal mat. Clasts present in this sediment type are almost entirely composed of pieces of algal mat and some associated micrite layers. Desiccation cracking and wave turbulence are probably the two most important mechanisms for producing a disturbed algal-mat biomicrite. Algal-mat intraclasts and adjacent layers of complete or partially torn-up algal mat suggest that the intraclasts were derived from the immediate vicinity and suffered little from mechanical attack. In many instances a discontinuous string of pebble size intraclasts can be seen as the remnants of a once continuous algal layer. General lack of sorting and subangular shape of intraclasts leads to this interpretation. Gradations between continuous algal-mat biomicrite and disturbed algal-mat biomicrite can be found in the strata investigated.

In some beds algal mat layers occur in a dominantly micritic or intraclastic rock. This lithology is referred to as either dolomitized algal mat-bearing micrite (or intramicrite), if algal layers constitute less than 10 percent of the rock, or as dolomitized sparse algal mat biomicrite, if algal layers constitute 10 to 50 percent of the rock.

Another sediment type in which blue-green algae are recognized is dolomitized intramicrites. Intraclasts of algal-mat composition are often abundant and interspersed with intraclasts of micrite. The rock is classified as an intraclastic rock when the algal-mat intraclasts do not appear to have come from the immediately adjacent or subjacent strata. The larger intraclasts, both those composed of torn-up algal mat and of torn-up micrite, have frequently been found to fall into the fine calcirudite class, 1 to 4 mm. These clasts are usually surrounded by a micrite matrix.

Finer sized intraclasts, ranging from coarse calcilutite (0.031 mm to 0.062 mm) to fine calcarenite (0.125 mm to 0.25 mm), occur as bands intercalated with either algal mats, micrite layers, or zones of coarser intraclasts. Fine intraclasts occasionally accumulated in isolated pockets in the algal mats or on top of micrite layers. These pockets or layers of intraclasts are usually much better sorted than the coarser intraclasts and rarely if ever found intermixed with the coarser material. The bands, in some instances, exhibit graded bedding. The finer intraclasts are commonly cemented by spar. In a few instances, channels, some as small as 1 cm across, have been cut into micrite layers and filled with very fine sand-sized clasts. One channel-fill specimen displayed graded bedding. In only one or two instances could clasts be identified as extraclasts (Wolf, 1965). Oölites are present but extremely rare.

The various sediment types found in the Milroy occur adjacent to one another and frequently two or more occur within the same bed. A bed is rarely composed of a single lithology and usually is a composite of the types mentioned above.

Burrows are common throughout the Milroy Member. However, it is often difficult to determine whether the "mottled" appearance of extensively dolomitized units is due to burrowing or is the result of some other property of the rocks leading to preferential dolomitization. Weathered rock surfaces frequently exhibit a pattern commonly referred to as "fucoidal;" in most instances this structure is the result of burrowing.

Individual dolomite rhombs are mostly finely crystalline (0.016 mm to 0.062 mm) in size with extremes ranging from very fine crystalline (0.004 to 0.016 mm) to medium crystalline (0.062 mm to 0.25 mm). The size range of individual crystals is usually small and there is a homogeneous complexion to the rock. Some single specimens contain dolomite rhombs of two different sizes adjacent to one another. This texture is believed to be the result of dolomite replacing former "structures," though only the outlines of the ghosts could be determined and not their original characteristics. Organic matter was frequently observed associated with many of the ghosts. This has led to the belief that these ghosts are the replaced remains of fossil material.

Many dolomite rhombs are very well developed and can easily be recognized. In strata which have been only partially dolomitized, dolomite rhombs "float" in a micrite matrix.

Limestone beds in the Milroy are quite similar to the dolomite beds in overall appearance. They are usually a little darker gray than the dolomite beds, however, they too range in color. Where they are weathered, the limestone beds are somewhat easier to distinguish. Their surface is very light gray (N8).

The limestone units are aphanitic and break with a conchoidal fracture similar in character to but less pronounced than that of the dolomite beds. The limestone layers are almost exclusively micritic. They ubiquitously exhibit evidence of dolomitization. Dolomite occurs as scattered rhombs or laminae in the micrite. Dolomite rhombs have been found as isolated crystals in micrite; irregular, wavy layers of rhombs alternating with layers of micrite, and as clusters of dolomite crystals surrounded by micrite.

Limestone beds contain the only abundant recognizable fossil remains found in the Milroy, with the exception of the stromatolites, which are found primarily within the dolomite beds. Fossils do not readily weather out of the rock. Concentrations of fossils are restricted to narrow bands within fossil-bearing beds. A few specimens from limestone beds contain fecal pellets. This occurrence is usually restricted to those beds which contain other fossil fragments.

Mentioned above is the common association of thinly laminated zones with intraclasts. Logan, Rezak, and Ginsburg (1964) have described a similar occurrence from Recent depositional environments. They found that "the sediments are usually wet and soft in the littoral but may grade into a blocky indurated calcarenite in the supralittoral; laminated flat-pebble conglomerate and breccias are common in this zone." Recognition of desiccation-cracked, algal-mat layers strongly suggests a supratidal or intertidal environment of deposition for some of the Milroy.

Rosebud concretions discussed above support this environmental interpretation if it is accepted that the concretions were originally evaporite rosettes, either anhydrite or gypsum. These minerals are known to form in the supratidal zone of the Persian Gulf (Kendall, 1966). There gypsum deposits begin to form from evaporitic processes at and above the algal flats bordering the strand line. Illing, Wells, and Taylor (1965) describe "small flattened gypsum crystals with a tendency to rosette shapes" first occurring immediately above the algal flats. Their size increases landwards and is concomitant with increasing dolomitization of the surrounding sediment. "In places the gypsum occurs as a poikilitic cement enclosing carbonate sediment of all kinds and forming irregularly shaped lumps up to several inches across." I believe that the rosebud concretions of the upper part of the Bellefonte Dolomite and of the Milroy are analogous to those described immediately above.

Taking this into consideration it appears that the Milroy was deposited in basins which must have ranged from very shallow water to supratidal. The Milroy Member represents a gradational succession of continuous deposition between the Beekmantown Group below and the Clover Limestone above.

Paleontology

The Milroy Member displays little faunal diversity. However, diversity of the phyla present and the genera within each phylum and the abundance of the fossil fragments increases with units of higher stratigraphic position.

Thinly-laminated stromatolite zones with "cryptozoon heads" occur throughout the transition zone. None of these were larger than 1½ feet laterally and 1 foot vertically. The structures are of the space-linked hemispheroid form (Logan, Rezak, Ginsburg, 1964); that is, the "space between the structures is greater than the diameter of the structures."

Logan, Rezak, and Ginsburg (1964) describe algal mats as thinly-laminated structures which act as sediment binders. These organosedimentary features "characteristically develop in continuous mats and algal-bound sediments from the marine, intertidal mud-flat environment, mainly in the protected locations of re-entrant bays and behind barrier islands and ridges where wave action is usually slight." They have found as many as 28 different genera of algae living in the community that builds Recent stromatolitic structures and morphology is usually due to the interaction of the algal mat, detrital sediment, and the physical environment factors.

Smooth ostracode carapaces, highly fragmented, are very abundant in limestone units. The ostracodes show no apparent change in form throughout their vertical distribution within the Milroy.

Trilobites occur within these transitional beds. Their first appearance is higher in the section than that of the ostracodes. Trilobite fragments are abundant at the Belleville locality and were collected from this site. The mode of preservation did not permit any identification of these pieces.

Abundant pelmatazoon fragments occur in limestone beds directly beneath the top of the Milroy. The lowest observed occurrence of pelmatazoon fragments was found in limestone beds slightly lesss than 30 feet below the top of the Milroy Member.

Gastropods resembling *Maclurites* were found just beneath the contact of the Milroy and Clover Members at the Sparr quarry locality.

Brachiopod and bryozoan fragments are uncommon in the interval assigned to the Milroy.

Residue analysis

An insoluble residue analysis was performed on samples from the Sparr quarry section.

The composition of the coarse insoluble residue of the whole transitional zone was uniform throughout and consisted of quartz and chert.

No systematic variation of the relative abundance between these two components was observed. X-ray diffraction recordings were made of several of the insoluble residues, and the patterns showed that feldspars, in addition to quartz and chert, were present in all the samples X-rayed.

The insoluble residue analysis was performed with the hope that some significant variation of the percentages by weight of insoluble residue in the samples would be found and related to the stratigraphic position. This hope was not realized.

The relative abundance of insoluble material in the limestone beds compared with those in the dolomite beds was investigated. No correlation was observed between percentage of insoluble residue and degree of dolomitization.

Clover Member

The Clover Member is generally a thin-bedded, relatively pure limestone. Its thickness is about 60 feet in the area of study. It is a dark fossiliferous limestone, containing a variety of different fossil groups. The Clover Limestone is generally a micrite and commonly referred to as sublithographic.

INTERPRETATIONS AND CONCLUSIONS

This investigation was initiated to determine the stratigraphic relationships between the Milroy and the Lower and Middle Ordovician strata. A disconformity has been recognized between the Lower and Middle Ordovician at many localities in the Appalachians. The problem as it exists in central Pennsylvania can be depicted as shown in Figure 3. Four interpretations are possible:

1) Following the deposition of the Beekmantown Group, the area under investigation may have been uplifted and eroded. The interval during which the erosion of this carbonate surface occurred would need to have been of sufficient magnitude to permit up to 400 feet of relief to develop. After this erosional surface had formed, the area was submerged and the Milroy Member was deposited. This was followed by deposition of the Clover Limestone as a continuous accumulation of carbonate sediments. In this model a disconformity exists between the Beekmantown Group, top of the Bellefonte Formation, and the bottom of the Milroy.

2) Another possible interpretation of this stratigraphic interval postulates continuous accumulation of sediment from the Beekmantown Group through the top of the Milroy Member. After accumulation of these transitional beds the area was then exposed to subaerial erosion. In this scheme, 400 feet of relief was developed upon this erosional surface.

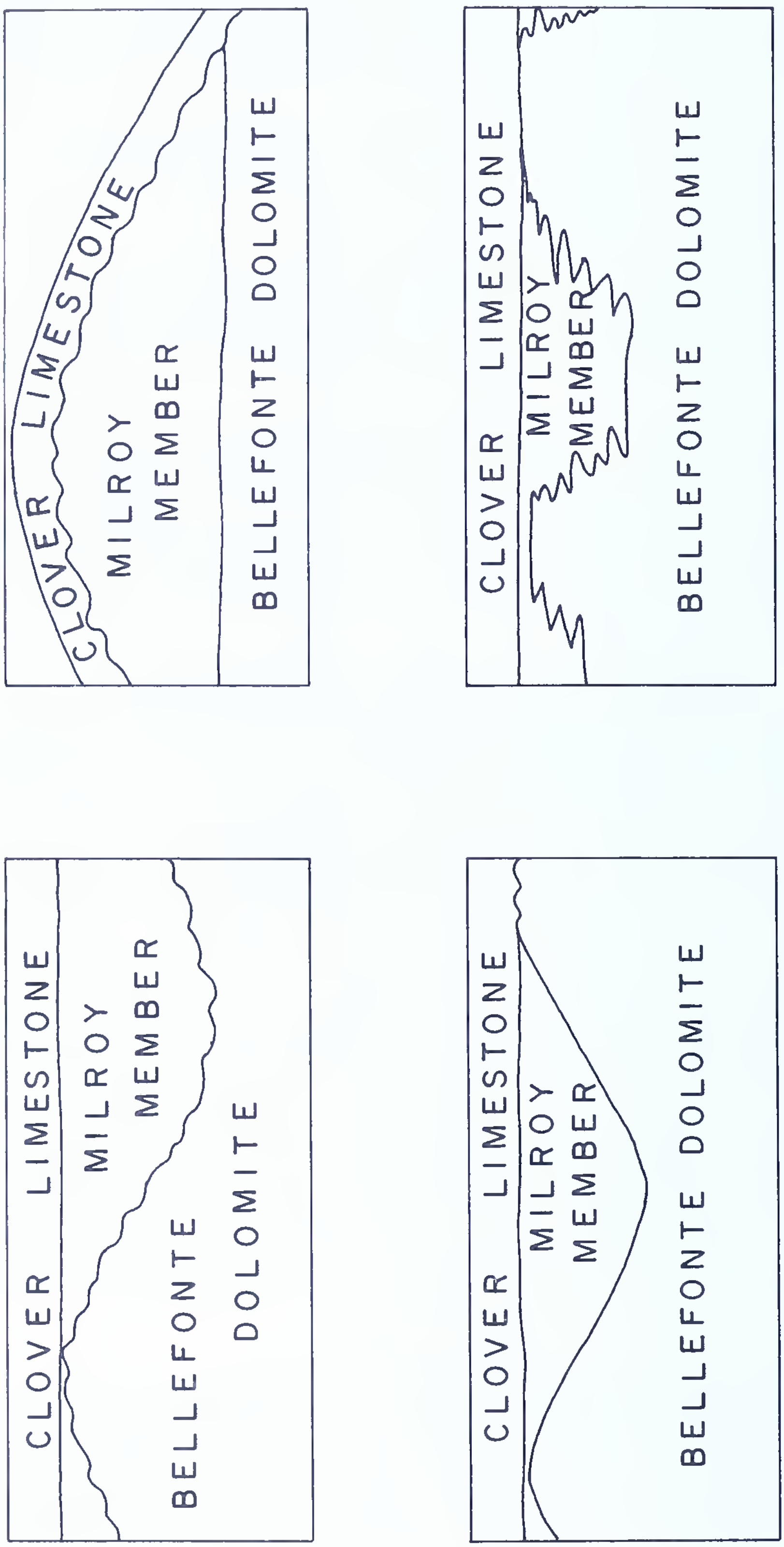


Figure 3. Schematic representation of alternative explanations for the sedimentological history of the Bellefonte-Clover sequence.

Following this erosion, which in some instances completely removed the previously deposited Milroy, strata were deposited which contained relatively very little dolomite. In this second hypothesis, a disconformity should be present between the top of the Milroy and the base of the Clover Limestone.

3) A third interpretation of the stratigraphic relationship envisions a continuous accumulation in "lows" and no deposition on penecontemporaneous "highs." Highs correspond to anticlines in the process of formation. This model suggests that the marine surface of deposition was an irregular surface of topographic highs and lows. This tectonic framework would account for the stratigraphic relationships observed and does not necessitate an unconformity between any of the units. Areas in which the Milroy Member is absent would represent the highs of the sea floor and those in which the beds attain their maximum thickness would represent the loci of the lows. This does not imply that these two parts always remained in the same geographic position and did not migrate. This is a distinct possibility, however, and no definitive statements can be made concerning this premise without further investigation. Areas of thick accumulation of the Milroy would represent continuous accumulation without erosion, while sections from which these units are absent could either be localities where subaerial or submarine erosion took place or they might represent zones of bypass.

This model of deposition controlled by an active basement during the early Paleozoic was postulated by B. N. Cooper (1964). He concerns himself in this paper in part with the same stratigraphic interval in the southern Appalachians as considered in this study.

4) A fourth alternative which would explain the highly variable thickness of the Milroy is that it is in part or total laterally equivalent to older or younger beds. It does not seem likely that the 400 plus feet of the Milroy are laterally equivalent to the Clover Limestone or younger beds. The Clover Limestone is approximately 60 feet thick in this area and its thickness does not vary significantly. However, it is possible that this transitional unit is laterally equivalent to the dolomite beds of the Bellefonte Formation. Kay (1944) felt that the varied lithologies of the Milroy are a "facies of a synchronous unit that has been called 'upper Bellefonte' or 'Loysburg,' depending on the dolomite content."

The writer favors the fourth alternative. However, the latter two interpretations are equally supported by the data gathered in this investigation. The first two possibilities, those requiring the presence of an unconformity, are rejected for the following reasons:

Nowhere was there any physical evidence for an unconformity. A disconformity along which up to 400 feet of erosion has occurred might

be expected to leave some physical evidence, either in the form of a surface of erosion or resulting deposits. Inability to observe a surface of truncation is not regarded as a serious objection because all sections observed were steeply dipping, on the order of 40 degrees, and therefore no individual surfaces could be traced for any considerable distance. However, it is believed that a basal conglomerate would have been present had the erosion taken place, that is, the residue from 400 feet of erosion.

The change from strata which are entirely dolomite (Bellefonte Formation) to those which are entirely limestone (Clover Formation) is gradual. No horizon displaying a sharp lithologic contrast can be demonstrated. The change occurs as dolomite beds of the Bellefonte Formation grade into intercalated dolomite and limestone beds. Dolomite layers are more abundant than limestone near the base of the Milroy, whereas the proportion of limestone increases upwards. This continues until the strata become composed entirely of limestone units in the Clover Limestone.

Lithology of the individual beds also gives very little evidence for any major break in deposition. Dolomite units of the Milroy cannot be distinguished from those of the Bellefonte Dolomite by petrographic means or by their insoluble residue content. Limestone layers of the Milroy are similar to those of the Loysburg Formation.

The faunal content of this transitional zone changes from low faunal diversity at the base to a greater faunal diversity at the top. This appears to grade into the faunal distribution as found in the Clover Limestone.

Attempts were made to correlate between the four measured and collected sections. Lithology, paleontology, and any associated features that were incorporated with the rock were used to try to tie sections together. However, correlation was not achieved.

Lack of correlation can be understood when considered in light of paleogeographic interpretations herein suggested for the area. Variations between sections suggest the possibility that these units were not deposited as continuous sheetlike layers as the early Paleozoic strata of the Appalachians are often envisioned. The fact that this sequence of rocks accumulated in a shallow to supratidal environment could account for the lack of correlation. There is a distinct possibility that the Milroy Member was deposited in semi-isolated depositional basins which were separated from each other by ridges, either submergent or emergent.

REFERENCES

Bridge, J. (1950), *Stratigraphy of the Mascot-Jefferson City Zinc District, Tennessee,* U. S. Geol. Survey Prof. Paper 277, 76 p.

__________ (1955), *Disconformity between Lower and Middle Ordovician series at Douglas Lake, Tennessee,* Geol. Soc. America Bull., v. 66, p. 725-730.

Butts, C. (1926), *Geology of Alabama,* Alabama Geol. Survey, Spec. Rept. 14, p. 40-230.

__________ (1939), *Topographic and geologic atlas of the Tyrone quadrangle, Pennsylvania,* Pennsylvania Geol. Survey, 4th ser., Atlas 96, 118 p.

__________ and Gildersleeve, B. (1948), *Geology and mineral resources of the Paleozoic area in northeast Georgia,* Georgia Geol. Survey Bull. 54, 176 p.

__________ and Moore, E. S. (1936), *Geology and mineral resources of the Bellefonte quadrangle, Pennsylvania,* U. S. Geol. Survey Bull. 855, 111 p.

Chafetz, Henry S. (1967), *Petrography and stratigraphy of the strata of the Lower-Middle Ordovician contact, central Pennsylvania.* Unpublished Masters thesis, Michigan State University, 86 p.

Cooper, B. N. (1944), *Geology and mineral resources of the Burkes Garden quadrangle, Virginia,* Virginia Geol. Survey Bull. 60, 299 p.

__________ (1964), *Relation of stratigraphy to structure in the southern Appalachians,* in *Tectonics of the southern Appalachians,* Lowry, W. D. (ed.), Vir. Polytech. Inst. Dept. Geol., Sci. Memoir 1, p. 81-114.

__________ and Prouty, C. E. (1943), *Stratigraphy of the lower Middle Ordovician of Tazewell County, Virginia,* Geol. Soc. America Bull., v. 54, p. 819-886.

Eardley, A. J. (1962), *Structural geology of North America,* (2nd edition), New York, Harper and Row, 743 p.

Folk, R. L. (1952), *Petrography and petrology of the Lower Ordovician Beekmantown carbonate rocks in the vicinity of State College, Pa.* Unpublished Ph.D. dissertation, The Pennsylvania State University, 366 p.

__________ (1959), *Practical petrographic classification of limestones,* Am. Assoc. Petroleum Geologists Bull., v. 43, p. 1-38.

__________ (1962), *Spectral subdivision of limestone types,* in *Classification of carbonate rocks—a symposium,* Ham, W. E. (ed.), Am. Assoc. Petroleum Geologists Memoir 1, p. 62-84.

Illing, L. V., Wells, A. J. and Taylor, J. C. M. (1965), *Penecontemporary dolomite in the Persian Gulf,* in *Dolomitization and limestone diagenesis, a symposium,* Pray, L. C. and Murray, R. C., (eds.) Society of Economic Paleontologists and Mineralogists, Spec. Pub. 13, p. 89-111.

Kay, G. Marshall (1944), *Middle Ordovician of central Pennsylvania,* Jour. Geology, v. 52, p. 1-23.

Kellberg, J. M. and Grant, L. T. (1956), *Coarse conglomerates of the Middle Ordovician in the southern Appalachian Valley,* Geol. Soc. America Bull., v. 67, p. 697-716.

Kendall, C. G. St. C. (1966), *Recent carbonate sediments of the western Khor al Bazam, Abu Dhabi, Trucial Coast.* Unpublished Ph.D. dissertation, University of London.

King, Philip B. and Ferguson, H. W. (1960), *Geology of northeasternmost Tennessee,* U. S. Geol. Survey Prof. Paper 311, 136 p.

Logan, B. W., Rezak, R., and Ginsburg, R. N. (1964), *Classification and environmental significance of algal stromatolites,* Jour. Geology, v. 72, p. 68-83.

Munyan, A. C. (1951), *Geology and mineral resources of the Dalton quadrangle, Georgia-Tennessee,* Georgia Geol. Survey Bull. 57, 128 p.

Pettijohn, F. J. (1957), *Sedimentary rocks* (2nd edition), New York, Harper and Bros. 718 p.

Prouty, C. E. (1946), *Lower Middle Ordovician of southwest Virginia and northeast Tennessee,* Am. Assoc. Petroleum Geologists Bull., v. 30, p. 1140-1191.

__________ (1948), *Trenton and sub-Trenton stratigraphy of northwest belts of Virginia and Tennessee,* Am. Assoc. Petroleum Geologists Bull., v. 32, p. 1596-1626.

__________, Aarons, I. I., McCollough, W. M., Mershon, R. E., and Miller, K. J. (1959), *Petrographic, chemical, and faunal studies, Cambro-Ordovician carbonates in the Sandhill Well, Wood County, West Virginia,* in *A symposium on the Sandhill Deep Well, Wood County, West Virginia,* Woodward, H. P. (ed.), West Virginia Geol. Survey, Rep. Inv. 18, p. 69-97.

Rock-Color Chart Committee, E. N. Goddard, Chairman (1963), *Rock-color chart,* National Research Council, Washington, D. C.

Rones, M. (1955), *A litho-stratigraphic, petrographic and chemical investigation of the lower Middle Ordovician carbonate rocks in central Pennsylvania.* Unpublished Ph.D. dissertation, The Pennsylvania State University, 345 p.

__________ (1969), *A lithostratigraphic, petrographic, and chemical investigation of the lower Middle Ordovician carbonate rocks in central Pennsylvania,* Pennsylvania Geol. Survey, 4th ser., Bull. G 53, 224 p.

Sloss, L. L. (1963), *Sequences in the cratonic interior of North America,* Geol. Soc. America Bull., v. 74, p. 93-114.

Wagner, Walter R. (1966), *Stratigraphy of the Cambrian to Middle Ordovician rocks of central and western Pennsylvania,* Pennsylvania Geol. Survey, 4th ser., Bull. G 49, 156 p.

Wilson, C. W. (1948), *The geology of Nashville, Tennessee,* Tennessee Div. Geology, Bull. 53, 172 p.

__________ (1949), *Pre-Chattanooga stratigraphy in central Tennessee,* Tennessee Div. Geology, Bull. 56, 407 p.

Wolf, K. H. (1965), *Gradational sedimentary product of calcareous algae,* Sedimentology, v. 5, p. 1-37.

APPENDIX

MEASURED SECTIONS

The five localities studied—Reedsville, Sparr quarry, Belleville, Loysburg, and Clover Creek—were designated by the letters R, S, B, L, and C respectively. The specimens from these localities were numbered in a consecutive order starting with number 1 at the beginning of each outcrop. When more than one sample was collected from a single bed the different samples were further designated by a small subscript letter following the number, so that the second sample from the 38th bed studied at Sparr quarry would be labeled S-38_B.

The terminology used to describe the strata studied in this investigation is a slightly modified version of Folk (1959, 1962).

SPARR QUARRY SECTION

(Williamsburg 7½-minute quadrangle, Pennsylvania, latitude 40°26′38″ N., longitude 78°10′48″ W.)

From the town of Williamsburg this locality can be reached by proceeding east on Third Street until the street ends at a hillside and at this point turning to the right along the stone wall. The road divides a short way from this point, and the left-hand fork uphill should be taken. Approximately a quarter of a mile out of town another left-hand turn is taken, again uphill. This road is taken until a dirt road entering from the right is encountered just before Clover Creek is reached. This dirt road is followed; the quarry is a short distance along this road. The second site of excavation is the locality at which this section was measured. This quarry was not in operation at the time of this study, summer of 1963, and had not been for a number of years. The strata are striking N. 17° E. and dipping 40 degrees to the southeast.

The lowest rock unit exposed in the quarry is the Bellefonte Dolomite and the highest in this section of the quarry is the Hatter Formation and possibly some of the unit directly above it. There are no covered sections and the exposure is good. The quarry was worked perpendicular to strike, leaving a good continuous outcrop. Approximately 170 feet of strata belonging to the Milroy Member crop out in the quarry and both the upper and the lower contacts are exposed.

Description	*Thickness in feet*	*Feet above base*
LOYSBURG FORMATION 197.9 feet measured.		
Clover Member 27.4 feet measured.		
S-62: Intramicrite, dolomitized in patches; minor amount of stromatolitic laminations; medium-light-gray to light-brown.	2.5	289.7
S-61: Intramicrite, partially dolomitized; clasts of at least three limestone lithologies, some of the clasts are well rounded; medium-gray to light-tan.	2.5	287.2
S-60: Medium crystalline dolomite rhombs well developed; wavy silty laminations; light-gray to light-olive-gray.	2.5	284.7
S-59: Dolomitized disturbed algal-mat biomicrite; minor amount of hematite in cubes; medium-gray to light-olive-gray.	2.5	282.2
S-58: Algal-mat biomicrite intercalated with micrite and intramicrudite, contains ostracodes, trilobites and brachiopods; medium-gray.	6.1	276.1
S-57: Grades from a dolomitized biomicrite up into an intramicrudite; medium-gray to light-olive-gray.	2.5	273.6
S-56: Sparse intramicrudite, contains minor amount of algal layers; partially dolomitized, laminated and intraclastic zone prominent near top of unit; dark-gray.	2.5	271.1
S55: Sparse intramicrite; partially dolomitized, rhombs well developed, contains hematite along fracures; medium-gray.	2.6	268.5
S-54: Fossiliferous intramicrudite and intrasparite; contains ostracodes, trilobites, echinoderm fragments, algal layers, *Maclurites*(?); dark-gray; fucoidal appearance on weathered surface.	3.7	264.8
Milroy Member 170.5 feet measured.		
S-53: Finely crystalline intraclastic dolomite; alternating bands of intramicrite and micrite up to 0.2 foot thick; contains 0.1 mm blobs of spar also a great abundance of hematite altering to limonite; light-olive-gray.	1.3	263.5
S-52: Dolomitized fossiliferous algal-mat intramicrudite and fossiliferous micrite; "cloudlike" mottled pattern due to dolomitization; dark-gray.	3.6	259.9
S-51: Dolomitized disturbed algal-mat intramicrite with bands of pure micrite; appears to be a solid stromatolitic mass; brownish-gray.	4.1	255.8
S-50: Fossiliferous intramicrudite; contains ostracodes, trilobites, and echinoderms(?); medium-gray; fucoidal appearance on weathered surface.	3.9	251.9
S-49: Fossiliferous biomicrite and fossiliferous intramicrudite; dolomitized in patches; contains ostracodes and trilobites; "cloudlike" mottled pattern due to dolomitization; medium-gray to light-olive-gray.	2.7	249.2

Description	*Thickness in feet*	*Feet above base*
S-48: Dolomitized fossiliferous pelmicrite; pellets exhibit cross bedding; minor amount algal-mat laminations; top of unit shows shaly parting; contains abundant pyrite; dark-gray.	4.2	245.0
S-47: Dolomitized calcareous shale dark-gray; very distinct in field.	0.6	244.4
S-46: Dolomtized fossiliferous pelmicrite and intramicrudite; contains algal-mat laminations; edgewise conglomerate near top of unit; medium-gray.	2.0	242.4
S-45: Dolomitized algal-mat biomicrite; algal layers selectively enriched in hematite; light-gray; laminations stand out well on weathered surface.	6.2	236.2
S-44: Dolomitized pellet-bearing biomicrite; mottled appearance due to dolomitization; spar occurs in layers; contains abundant pyrite and hematite; medium-gray.	2.7	233.5
S-43: Fossiliferous and algal mat-bearing intramicrudite; contains ostracodes and trilobites; some of the clasts are torn-up algal mat; a few of the clasts show a concentration of hematite; medium-gray to brownish-gray.	6.6	226.9
S-42: Dolomitized burrowed dismicrite; rich in organic matter and hematite; medium-gray.	5.2	221.7
S-41: Dolomitized algal-mat biomicrite; dolomitized in strips; algal layers 1 to 2 mm thick; medium-gray.	8.2	213.5
S-40: Finely crystalline dolomite; no visible structure; rich in organic matter and pyrite; medium-gray.	8.3	205.2
S-39: Dolomitized disturbed algal-mat biomicrite; dolomitized in bands; prominent stromatolitic appearance to the unit; laminated bands 0.4 to 1.5 feet thick; edgewise conglomerate near top; dark-gray.	8.7	196.5
S-38: Finely crystalline dolomite; concentrations of well developed dolomite crystals; rich in pyrite; dark-gray.	13.3	183.2
S-37: Dolomitized micrite intercalated with pelsparite; lower portion of unit has rosebud concretion zone; middle portion dolomite with calcite in bands; top of unit is a finely crystalline dolomite; dark-gray.	7.6	175.6
S-36: Dolomitized disturbed algal-mat biomicrite; burrowed; medium-gray.	8.2	167.4
S-35: Dolomitized intraclast-bearing dismicrite; abundant hematite in veins associated with larger crystals of dolomite; medium-gray.	1.9	165.5
S-34: Dolomitized micrite; completely dolomitized; rich in disseminated hematite; brownish-gray; shaly parting on weathering.	5.8	159.7
S-33: Dolomitized intraclast-bearing algal-mat biomicrite; algal mats abundant along base of unit; intramicrite prominent at top; magnetite concentrations along joints; medium-gray.	2.4	157.3

Description	*Thickness in feet*	*Feet above base*
S-32: Micrite; rich in organic matter, hematite, and some clear quartz grains; unit is shaly near its base, laminations increase upwards, topped by thin striped zone; medium-dark-gray.	0.8	156.5
S-31: Dolomitized algal mat-bearing micrite, some pelsparite zones; sorting of two different sized dolomite crystals yield distinguishable layers; poorly defined tiger-striped appearance; medium-gray.	10.2	146.3
S-30: Dolomitized pelletiferous micrite; medium to medium-dark-gray.	3.3	143.0
S-29: Dolomitized algal-mat biomicrite; finely laminated; abundant stylolites; medium-gray.	10.0	133.0
S-28: Pellet-bearing ostracode biomicrite; dolomitized in strips; prominent tiger-striped unit, forms overhanging ledge in quarry; medium-gray.	6.7	126.3
S-27: Shaly dolomitized algal-mat biomicrite; rich in organic matter; dark-gray.	0.2	126.1
S-26: Dolomitized pelletiferous and algal mat-bearing intramicrudite; rich in hematite; medium-dark-gray.	2.6	123.5
S-25: Finely crystalline biogenic dolomite; appears to be replaced algal mat with some intraclastic zones; contains a sparse concentration of rosebuds in lower 2 feet of unit, rosebuds are anhydrite; light-brownish-gray.	6.6	116.9
S-24: Dolomitized algal-mat biomicrite; contains a coarse intramicrite in middle of bed; abundant pyrite crystals; finely laminated lower portion of unit; medium- to medium-dark-gray.	3.9	113.0
S-23: Dolomitized intramicrudite and dolomitized algal-mat biomicrite; some dolomitized micrite zones; well developed rosebud concretion zone about 5 feet from base of unit, rosebuds of calcite; stromatolitic "head" from lower part of unit projects along minor break into middle part of unit, head approximately 1.5 feet long and 0.5 foot high; medium-dark-gray.	7.1	105.9
S-22: Varies from dolomitized algal-mat biomicrite at base to dolomitized micrite to micrite at top; medium-dark- to medium-light-gray.	8.0	97.9
S-21: Dolomitized sparse algal-mat biomicrite; medium-gray.	0.6	97.3
S-20: Algal-mat biomicrite; partially dolomitized in bands, mottled; form tiger-striped unit; medium-gray.	3.0	94.3

BELLEFONTE DOLOMITE 94.3 feet measured.

Description	*Thickness in feet*	*Feet above base*
S-19: Dolomitized micrite; dolomite rhombs of medium crystal size (0.0625 to 0.25 mm); randomly distributed pores have pyrite in centers; medium- to medium-dark-gray.	4.0	90.3
S-18: Dolomitized sparse algal-mat biomicrite; structures somewhat obscured by mottling; medium-gray.	0.8	89.5

Description	*Thickness in feet*	*Feet above base*
S-17: Dolomitized intramicrudite and algal-mat biomicrite; grades up into more limy portion; edgewise conglomerate just beneath top of unit; medium-gray.	6.3	83.2
S-16: Dolomitized algal-mat intramicrudite; rich in hematite and pyrite; red staining prominent; medium-light-gray.	5.0	78.2
S-15: Dolomitized algal-mat intramicrudite; laminated zone grades upward into intraclastic zone; red staining prominent; medium-light-gray.	4.8	73.4
S-14: Dolomitized pelletiferous algal-mat biomicrite; dolomite rhombs in bands; prominent red staining; medium-light-gray.	2.6	70.8
S-13: Dolomitized fossiliferous micrite; contains a small percentage of sponge spicules; has graded cross-bedded allochems; top of unit has a prominent rosebud zone, rosebuds filled with sparry calcite around the outside and with quartz crystals filling the centers; randomly distributed oxidized pyrite crystals; brownish-gray to pale-yellowish-brown; "stylolitelike" relief along top of bed.	3.4	67.4
S-12: Dolomitized pelmicrite; streaks of hematite staining; medium-gray; stylolitic relief both top and bottom of bed.	3.4	64.0
S-11: Dolomitized pelmicrite; mottled; calcite rosebud zone, buds up to 0.8 foot long; prominent silty zones; medium-dark-gray.	3.9	60.1
S-10: Dolomitized pelmicrite; algal-mat layers; two prominent rosebud zones; medium-dark-gray.	7.5	52.6
S-9: Finely crystalline dolomite; mottled; weathered surface shows algal(?) laminations; medium-gray.	3.7	48.9
S-8: Finely crystalline biogenic dolomite; mottled; stromatolitic laminations and crowns stand out on weathered surface; calcite rosebud concretionary zone approximately 3 feet above base; stylolites well developed; medium-gray; relief along beds; top surface is stylolitic.	10.7	38.2
S-7: Finely crystalline biogenic dolomite; mottled: algal-mat laminations stand out on weathered surfaces, rich in hematite crystals after pyrite; dolomite rhombs vary considerably in size; light-brownish-gray.	9.5	28.7
S-6: Finely crystalline biogenic dolomite; calcite rosebud concretionary zone about 2.5 feet above base of unit; medium-dark-gray to brownish-gray.	5.9	22.8
S-5: Finely crystalline biogenic dolomite; algal laminations stand out on weathered surfaces; medium-dark-gray; relief up to 0.5 foot along top of bed.	4.7	18.1
S-4: Finely crystalline biogenic dolomite; small calcite rosebud concretions; medium-gray.	3.1	15.0
S-3: Finely crystalline biogenic dolomite; light-brownish-gray.	6.0	9.0
S-2: Dolomitized algal-mat biomicrite and intramicrudite; medium-gray.	6.0	3.0
S-1: Finely crystalline biogenic dolomite; algal laminations; medium-gray.	3.0	0.0

REEDSVILLE SECTION

(Lewistown 15-minute quadrangle, Pennsylvania, latitude 40°40′34″ N., longitude 77°35′70″ W.)

This section is situated along Route 322 between Reedsville and Milroy, approximately three-quarters of a mile northwest of Reedsville. The average strike of the outcrop is about N. 48° E. and dips 43 degrees to the southeast.

The strata crop out in three sections: the first consisting entirely of the Tea Creek Dolomite, the second of both Tea Creek Dolomite and Milroy Member, and the third of Milroy Member and the Clover Limestone and younger formations. A large covered area, 120 feet stratigraphically, exists between the second and third sections, within the Milroy.

The part of the outcrop which was measured and collected, consisting of a portion of the Bellefonte Dolomite up to the Eyer Member of the Hatter Formation, is 630 feet thick. The Milroy Member is approximately 380 feet thick at this locality.

Description	*Thickness in feet*	*Feet above base*
LOYSBURG FORMATION		
Clover Member 47.3 feet measured.		
R-78: Fossiliferous micrite; contains abundant ostracodes, also trilobites, gastropods, and brachiopods; medium-dark-gray.	2.5	665.3
covered:	37.0	628.3
R-77: Algal-mat biomicrite; finely laminated, small crowns observed; medium-dark-gray.	3.0	625.3
covered:	3.5	621.8
R-76: Ostracode-bearing disturbed algal-mat biomicrite; contains *Tetradium*(?); medium-dark-gray.	1.4	620.4
covered:	2.5	617.9
Milroy Member 387.5 feet measured.		
R-75: Dolomitized micrite; shaly parting, very friable; medium-gray.	4.0	613.9
covered:	1.3	612.6
R-74: Algal-mat and ostracode-bearing intramicrudite; irregular wavy laminations on weathered surface; medium-gray to light-brownish-gray.	1.5	611.1
covered:	1.2	609.9
R-73: Dolomitized algal-mat biomicrite; medium-gray to light-brownish-gray.	1.8	608.1
covered:	3.0	605.1

Description	*Thickness in feet*	*Feet above base*
R-72: Intrasparite with minor amounts of oösparite; terrigenous clasts (extraclasts); medium-gray.	1.0	604.1
covered:	1.0	603.1
R-71: Disturbed algal-mat biomicrite; contains ostracodes; medium-gray to light-brownish-gray.	2.0	601.1
covered:	19.0	582.1
R-70: Dolomitized algal-mat biomicrite; medium-gray.	3.0	579.1
R-69: Sparse algal-mat biomicrite; irregular wavy laminations on weathered surfaces; medium-dark-gray to dark-gray.	2.0	577.1
R-68: Burrowed ostracode and trilobite-bearing intramicrudite; contains crinoids and brachiopods; contains blobs of hematite; weathers out to a "punky" limestone; medium-gray.	2.4	574.7
R-67: Dolomitized micrite; mottled; massive; medium-dark to dark-gray.	8.0	566.7
R-66: Dolomitized dismicrite; brownish-gray.	10.0	556.7
R-65: Fossiliferous micrite; contains ostracodes; prominent tiger-striped unit; medium- to medium-dark-gray.	12.0	544.7
R-64: Mixed biomicrite; contains algal layers, ostracodes, trilobites, sponge spicules, and bryozoans; medium-gray to light-brownish-gray; weathered surface shows a fucoidal pattern.	12.0	532.7
R-63: Dolomitized algal-mat biomicrite; very rich in pyrite; massive appearing unit; medium-dark-gray.	4.0	528.7
covered:	2.1	526.6
R-62: Dolomitized dismicrite; burrowed; thin bands of intramicrite; light-brownish-gray.	1.5	525.1
R-61: Micrite; tiger-striped unit; medium-gray to light-brownish-gray.	10.0	515.1
covered:	3.7	511.4
R-60: Burrowed ostracode and trilobite-bearing intramicrudite; minor amount of sparry cement; tiger-striped unit; brownish-gray.	3.5	507.9
covered:	121.0	386.9
R-56: Dolomitized algal-mat biomicrite; light-brownish-gray.	4.5	382.4
R-55: Burrowed intramicrite; massive appearing unit; medium-gray.	2.5	379.9
R-54: Algal-mat biomicrite; poorly defined tiger-striped unit; medium-dark-gray; weathered surface shows a fucoidal pattern.	12.6	367.3
R-53: Intramicrudite and burrowed algal-mat biomicrite; medium-gray to light-brownish-gray.	3.4	363.9
R-52: Dolomitized disturbed algal-mat biomicrite and intramicrudite; massive appearing unit; brownish-gray.	4.9	359.0
R-51: Disturbed algal-mat biomicrite, with patches of intrasparite; finely laminated; medium-dark-gray.	3.8	355.2
R-50: Ostracode-bearing sparse biomicrite; poorly defined tiger-striped unit; medium-dark-gray; weathers to a creamy white.	3.6	351.6

Description	*Thickness in feet*	*Feet above base*
R-49: Micrite; dolomitized in strips; grades into tiger-striped unit at top; medium-gray.	2.4	349.2
R-48: Dolomitized burrowed algal-mat biomicrite; massive appearing unit; medium-dark-gray.	4.5	344.7
R-47: Dolomitized disturbed algal-mat biomicrite; light-brownish-gray to brownish-gray.	2.1	342.6
R-46: Sparse algal-mat biomicrite; medium-dark-gray.	9.5	333.1
R-45: Dolomitized intramicrudite; medium-gray to brownish-gray.	2.5	330.6
R-44: Trilobite and ostracode-bearing algal-mat intramicrudite; medium-gray; shows zones of cavity development; fucoidal weathering pattern.	1.8	328.8
R-43: Burrowed algal-mat biomicrite; flat algal mats separate yielding a sort of "shaly" parting; medium-gray.	1.9	326.9
R-42: Sparse intramicrudite; medium-dark-gray; weathers to white.	2.3	324.6
R-41: Intramicrudite; medium-gray.	7.9	316.7
R-40: Micrite with minor amounts of fine intrasparite layers containing ostracodes; medium-dark-gray.	1.0	315.7
R-39: Dolomitized intramicrite; shows small-scale cross-bedding; massive appearing unit; pinkish-gray to medium-gray.	3.5	312.2
R-38: Dolomitized micrite; contains incipient rosebud concretions, less than 1 cm in diameter; massive appearing unit; medium-gray.	3.5	308.7
R-37: Algal-mat biomicrite; tiger-striped unit; incipient rosebud concretions; medium-dark-gray.	4.8	303.9
R-36: Mixed fossiliferous intramicrudite; contains crinoids, gastropods, trilobites, and ostracodes; medium-gray to light-brownish-gray; fucoidal weathering pattern.	5.3	298.6
R-35: Burrowed intramicrite; very prominent tiger-striped unit, layers vary from less than 0.1 foot to approximately 0.3 foot thick, usually less than 0.1 foot, breaks up along these different layers similar to shaly parting; medium-gray.	9.0	289.6
R-34: Dolomitized burrowed sparse intramicrite and algal-mat biomicrite; massive appearing unit; vein filled by colloform hematite; medium-gray to pinkish-gray.	3.6	286.0
R-33: Dolomitized micrite; prominent dolomitized stringers; medium-gray.	1.4	284.6
R-32: Intramicrudite; massive appearing unit; medium-dark-gray.	1.5	283.1
R-31: Sparse algal-mat biomicrite; minor amount of tiger-stripelike lithology; medium-dark-gray.	1.4	281.7
R-30: Sparse intramicrite; prominent tiger-striped unit; medium-dark- to dark-gray.	3.1	278.6
R-29: Dolomitized micrite; patches of pyrite; dark gray.	1.7	276.9
R-28: Fossiliferous micrite; contains ostracodes and algal layers; medium-gray.	1.2	275.7

Description	Thickness in feet	Feet above base
R-27: Dolomitized algal-mat biomicrite; medium-gray to brownish-gray; weathers to a creamy white.	1.3	274.4
R-26: Sparse algal-mat biomicrite; medium-dark-gray.	3.8	270.6
R-25: Sparse algal-mat biomicrite; medium-dark-gray.	0.8	269.8
R-24: Sparse ostracode biomicrite; prominent tiger-striped unit; medium-dark-gray.	4.6	265.2
covered:	2.7	262.5
R-23: Dolomitized algal-mat intramicrudite; medium-light-gray to light-brownish-gray; grades into R-22.	1.3	261.2
R-22: Dolomitized burrowed algal-mat biomicrite; massive appearing unit; medium-gray.	1.6	259.6
R-21: Intrasparite intercalated with micrite; medium-dark-gray to brownish-gray.	2.0	257.6
R-20: Intramicrite intercalated with micrite; medium-dark-gray.	1.8	255.8
R-19: Micrite intercalated with intramicrite; medium-gray.	1.9	253.9
R-18: Dolomitized intramicrudite; medium-gray to light-brownish-gray.	3.7	250.2
R-17: Dolomitized micrite, minor amount of intrasparite; contains vugs of calcite; medium-light-gray.	2.3	247.9
R-16: Dolomitized micrite; medium-gray.	2.2	245.7
R-15: Micrite, minor amount of intramicrite; massive appearing unit; brownish-gray.	3.2	242.5
covered:	9.5	233.0
BELLEFONTE DOLOMITE 231.0 feet measured.		
R-14: Dolomitized burrowed algal-mat biomicrite with layers of intrasparite; massive appearing unit; light-brownish-gray.	2.0	231.0
R-13: Dolomitized algal-mat biomicrite; medium-gray.		207.0
R-12: Dolomitized sparse algal-mat intramicrite; very dense, hard rock; medium-gray.		194.0
R-11: Dolomitized micrite; thin discontinuous stringers of limonite stain; light-brownish-gray to brownish-gray.		172.0
R-10: Dolomitized sparse algal-mat biomicrite; medium-gray to brownish-gray.		160.0
R-9: Dolomitized intramicrite; medium-gray to brownish-gray.		136.0
R-8: Dolomitized micrite; light-brownish-gray.		118.5
R-7: Dolomitized sparse intramicrudite; pinkish-gray.		117.0
R-6: Dolomitized burrowed algal-mat biomicrite; laminations stand out well on weathered surface; medium-dark-gray.		90.5
R-5: Finely crystalline dolomite; laminations stand out on weathered surfaces; medium-light-gray.		73.0
R-4: Finely crystalline dolomite; light-olive-gray.		47.0
R-3: Finely crystalline dolomite; prominent cavernous zone; light-olive-gray.		17.5
R-2: Finely crystalline dolomite; light-olive-gray.		10.5
R-1: Dolomitized sparse intramicrudite, contains red stains; light-brownish to brownish-gray.		1.0

LOYSBURG SECTION

(Everett 15-minute quadrangle, Pennsylvania, latitude 40°08′15″ N., longitude 78°23′30″ W.)

This section is situated along the east bank of Beaver Creek approximately 1¼ miles south of the town of Loysburg on the east side of Route 36. The strata have a strike of about N. 14° E. and a dip of 39 degrees to the southeast.

The lower end of the section is at the junction of a dirt road which enters Route 36 from the east, just south of the school in the pasture south of the bridge crossing Beaver Creek. This lower end of the outcrop is in the Bellefonte Dolomite, and the highest strata collected were part of the Hatter Formation, Eyer Member, which was encountered on the hillside overlooking the creek.

The strata that cropped out here were usually highly weathered and overgrown with vegetation, mainly moss. Two hundred and seventy feet of Milroy was measured at this locality; however, there may be as much as 350 feet as neither contact could be precisely established.

Description	*Thickness in feet*	*Feet above base*
HATTER FORMATION		
L-1: Sandy intraclast-bearing mixed biosparite; contains abundant crinoid remains, plus brachiopods, trilobites and bryozoans; rich in hematite; medium-gray.	2.2	442.4
covered:	60.8	381.6
LOYSBURG FORMATION		
Clover Member 60.8 feet (covered).		
Milroy Member 276.6 feet measured.		
L-2: Algal-mat biomicrite and intercalated intramicrite; mottled; very thinly laminated; very rich in pyrite; medium-dark-gray.	1.0	380.6
L-3: Burrowed algal-mat intramicrudite; medium-dark to dark-gray.	5.0	375.6
covered:	6.0	369.6
L-4: Disturbed algal-mat biomicrite and intercalated intramicrite; contains ostracodes; silt-sized carbonate grains sorted into layers; medium-dark-gray.	3.0	366.6
covered:	4.0	362.6
L-5: Burrowed fossiliferous intramicrudite; numerous burrows; contains ostracodes; medium-gray.	3.0	359.6
covered:	2.0	357.6

Description	*Thickness in feet*	*Feet above base*
L-6: Sparse algal-mat biomicrite; mottled; laminations stand out well on weathered surfaces; dark-gray.	1.5	356.1
L-7: Dolomitized algal-mat biomicrite; medium- to medium-dark-gray.	3.4	352.7
L-8: Dolomitized algal-mat biomicrite; mottled; medium-gray.	4.0	348.7
covered:	1.0	347.7
L-9: Ostracode-bearing algal-mat intramicrudite; medium-gray; outcrop poor.	1.0	346.7
covered:	1.0	345.7
L-10: Ostracode and algal mat-bearing intramicrite; medium-gray.	2.0	343.7
L-11: Ostracode-bearing disturbed algal-mat biomicrite; irregular vugs of spar approximately 1 mm in diameter; medium-gray.	1.3	342.4
covered:	1.8	340.6
L-12: Disturbed algal-mat biomicrite; contains patches of spar, resembles a dismicrite; light-brownish-gray to brownish-gray.	2.0	338.6
L-13: Ostracode and trilobite-bearing micrite; brownish-gray; weathers to a "creamy white."	0.8	337.8
L-14: Finely crystalline dolomite; mottled; medium-gray to brownish-gray.	2.5	335.3
L-15: Dolomitized disturbed algal-mat biomicrite; concentrations of pyrite alternating with hematite; thin bedded; medium-gray to brownish-gray.	1.2	334.1
L-16: Dolomitized micrite; mottled; medium-gray to light-brownish-gray.	2.4	331.7
L-17: Trilobite and ostracode-bearing disturbed algal-mat biomicrite; medium-dark-gray.	4.8	326.9
L-18: Fossiliferous micrite; contains ostracodes; brownish-gray; massive, weathers white.	1.8	325.1
covered:	3.0	322.1
L-19: Algal-mat biomicrite and micrite; banded, bands 0.1 to 0.8 foot thick; medium-gray.	3.2	318.9
L-20: Sparse algal-mat biomicrite; medium-gray to brownish-gray.	2.5	316.4
L-21: Dolomitized intramicrite; mottled; peculiar red staining; patches of solid hematite after pyrite; medium-gray to light-brownish-gray.	1.8	314.6
L-22: Burrowed ostracode and trilobite-bearing intramicrudite; brownish-gray; mottling caused by burrows seen on weathered surfaces.	2.6	312.0
covered:	1.0	311.0
L-23: Disturbed algal-mat biomicrite; contains a few ostracode shells; medium-dark-gray.	2.8	308.2
L-24: Dolomitized disturbed algal-mat biomicrite; red staining; medium-gray to light-brownish-gray.	3.5	304.7
covered:	2.1	302.6

Description	*Thickness in feet*	*Feet above base*
L-25: Mixed biomicrite; contains brachiopods, ostracodes, and crinoid stems; medium-dark-gray.	0.6	302.0
covered:	1.5	300.5
L-26: Dolomitized algal-mat biomicrite; contains crinoid stems; "cloudlike" dolomitization pattern; medium- to medium-dark-gray.	2.5	298.0
L-27: Dolomitized disturbed algal-mat biomicrite and intramicrite; appears to be burrowed; medium-gray.	2.5	295.5
L-28: Intrasparite and micrite; medium-dark-gray.	2.0	293.5
covered:	2.8	290.7
L-29: Disturbed algal-mat biomicrite; burrowed; "v-shaped" indentations in algal mat are due to desiccation, desiccation cracks; medium-gray.	1.5	289.2
L-30: Fossiliferous intramicrudite; contains ostracodes; medium-dark-gray; weathers to a creamy white; grades into L-31.	0.7	288.5
L-31: Disturbed algal-mat biomicrite; medium-dark-gray; grades into L-32.	0.7	287.8
L-32: Fossil-bearing intramicrudite; contains ostracodes, trilobites, and algal mats, rich in hematite; medium-dark-gray.	0.9	286.9
L-33: Micrite; medium-dark- to dark-gray.	2.1	284.8
L-34: Ostracode- and trilobite-bearing intramicrudite; dolomitized in strips; medium-gray; burrowing probably causes fucoidal appearance on weathered surfaces.	4.4	280.4
L-35: Dolomitized ostracode- and trilobite-bearing intramicrudite; heavily dolomitized in strips; medium-dark-gray.	1.2	279.2
L-36: Dolomitized micrite; layered; mottled; hematite in smears and thin irregular streaking; light-brownish-gray to medium-gray.	2.0	277.2
L-37: Micrite and intercalated intramicrite; weathered surface shows a tiger-striped pattern; medium-dark-gray.	1.5	275.7
L-38: Dolomitized sparse intramicrite; exhibits rippled surface on polished face; banded; medium-gray.	4.4	271.3
L-39: Dolomitized sparse biomicrite and intramicrite; mottled; irregular bands of hematite; light-brownish-gray to medium-gray.	3.0	268.3
L-40: Algal-mat biomicrite; contains ostracodes; "cloudlike" dolomitization pattern; fucoidal appearance on weathered surface; medium-dark-gray.	1.3	267.0
L-41: Dolomitized burrowed intramicrudite; rich in finely disseminated hematite; medium-light-gray to brownish-gray.	3.5	263.5
L-42: Dolomitized sparse intramicrudite; medium-dark-gray.	1.0	262.5
covered:	1.5	261.0
L-43: Dolomitized burrowed intramicrudite; medium-gray.	4.5	256.5
covered:	3.4	253.1
L-44: Dolomitized algal mat-bearing intramicrudite; medium-gray.	3.9	249.2
L-45: Dolomitized micrite; dolomite rhombs finer in size than the normal range; brownish-gray to medium-gray.	5.2	244.0

Description	*Thickness in feet*	*Feet above base*
L-46: Dolomitized micrite; banded; medium-dark-gray.	11.0	233.0
L-47: Dolomitized micrite; dolomite rhombs coarser than usual, medium crystalline range; irregular streaks of concentrated hematite; medium-dark-gray to brownish-gray.	2.0	231.0
L-48: Micrite; medium-dark-gray.	0.8	230.2
L-49: Dolomitized micrite; medium-gray.	0.5	229.7
L-50: Dolomitized micrite; mottled; medium-dark-gray.	0.7	229.0
L-51: Intraclast-bearing sparse biomicrite; contains algal mats and ostracodes; tiger-striped unit in field; medium-dark-gray.	1.8	227.2
L-52: Dolomitized intraclast-bearing burrowed algal-mat biomicrite; contains ostracodes; medium-dark-gray.	4.5	222.7
covered:	3.0	219.7
L-53: Dolomitized micrite; medium-gray to medium-dark-gray.	0.5	219.2
covered:	2.0	217.2
L-54: Dolomitized dismicrite; medium-gray to light-brownish-gray; grades into L-55.	3.0	214.2
L-55: Intraclast-bearing sparse ostracode and algal-mat biomicrite; prominent tiger-striped unit; medium-dark-gray.	7.0	207.2
L-56: Dolomitized sparse algal-mat biomicrite; medium-gray.	2.4	204.8
L-57: Dolomitized sparse intramicrite; shows small channels of hand-specimen size; massive appearing unit; medium-gray to light-brownish-gray.	2.4	202.4
L-58: Dolomitized sparse intramicrite; laminations stand out on weathered surfaces; medium-dark-gray.	2.5	199.9
L-59: Dolomitized micrite; banded; dark-gray; approximately 0.3 foot relief at top and bottom of the unit.	4.3	195.6
L-60: Dolomitized sparse intramicrite; shows cross-bedding of fine clasts on hand-specimen scale; finely disseminated hematite; light-brownish-gray.	3.9	191.7
L-61: Micrite; laminated; very thin-bedded; medium-dark-gray.	2.0	189.7
L-62: Micrite; mottled; light-brownish-gray.	2.1	187.6
L-63: Oölite-bearing intrasparrudite; light-brownish-gray.	4.4	183.2
L-64: Sparse algal-mat biomicrite; medium-dark-gray.	1.7	181.5
covered:	4.0	177.5
L-65: Sparse algal-mat biomicrite; dolomitized in stringers; medium-dark-gray.	0.4	177.1
covered:	2.3	174.8
L-66: Dolomitized micrite; medium-dark-gray.	1.6	173.2
L-67: Intramicrite intercalated with bands of micrite; channel in hand specimen, channel deposit exhibits graded bedding as do the intramicrite layers; light-brownish-gray to medium-gray; weathers to a creamy white.	0.5	172.7
L-68: Dolomitized micrite and intercalated intrasparite; graded deposit in channel in hand specimen; light-brownish-gray.	1.5	171.2

Description	*Thickness in feet*	*Feet above base*
L-69: Dolomitized micrite; banded; medium-gray to light-brownish-gray.	8.8	162.4
L-70: Dolomitized sparse algal-mat biomicrite; medium-dark-gray.	4.1	158.3
L-71: Dolomitized micrite; banded; prominent red staining; medium-gray to light-brownish-gray.	3.9	154.4
covered:	12.0	142.4
L-72: Dolomitized sparse intramicrudite; medium-gray to light-brownish-gray; resembles type Tea Creek lithology.	6.2	136.2
L-73: Dolomitized intramicrite intercalated with layers of intrasparite; light-brown mottling; medium-gray; resembles type Tea Creek lithology.	9.3	126.9
L-74: Dolomitized algal-mat biomicrite; medium-dark-gray.	10.2	116.7
covered:	2.0	114.7
L-75: Dolomitized algal-mat biomicrudite; medium-gray to light-brownish-gray.	0.7	114.0
covered:	1.2	112.8
L-76: Algal mat-bearing intramicrudite; medium-dark-gray.	1.8	111.0
covered:	12.0	99.0

BELLEFONTE DOLOMITE 105.0 feet measured.

L-77: Dolomitized algal mat-bearing biomicrite; "cloudlike" dolomitization pattern; medium-light-gray.	4.0	95.0
covered:	45.0	50.0
L-78: Dolomitized algal-mat biomicrite; very thin-bedded; medium-gray.		45.0
L-79: Dolomitized micrite; mottled; light-brownish-gray.		25.0
L-80: Dolomitized micrite; dark-gray.		10.0

CLOVER CREEK SECTION

(Martinsburg 7½-minute quadrangle, Pennsylvania, latitude 40°18′15″ N., longitude 78°17′15″ W.)

This section was measured along Route 164 east of the town of Clover Creek. It begins approximately 500 feet east of the location at which Route 164 crosses over Clover Creek. The strata crop out on the northeast side of the road and strike N. 18° E. with a dip of 32 degrees to the southeast.

The lowest strata are assigned to the Milroy Member, 148 feet of which are exposed at this locality. The contact, between the Milroy and the Clover Limestone is readily determined. The lower 55 feet of this section is discontinuous while the upper portion contains almost no covered intervals.

Description	*Thickness in feet*	*Feet above base*
LOYSBURG FORMATION		
Clover Member 14.2 feet measured.		
C-33: Intraclast-bearing mixed biomicrite; contains ostracodes, trilobites, gastropods, bryozoans, and crinoids; medium-dark-gray.	3.0	150.9
C-32: Burrowed algal-mat biomicrite; very thin-bedded; medium-gray.	5.0	145.9
covered:	1.0	144.9
C-31: Dolomitized disturbed algal-mat biomicrite; medium-gray.	0.4	144.5
covered:	0.6	143.9
C-30: Dolomitized micrite; mottled by dolomitization; massive appearing unit; light-brownish-gray.	2.2	141.7
C-29: Mixed biomicrite; very fossiliferous, mostly ostracodes with trilobites, crinoids, bryozoans, and corals(?); tiger-striped unit; medium-dark-gray.	2.0	139.7
Milroy Member 139.7 feet measured.		
C-28: Dolomitized sparse intramicrite, grades upward into an intramicrite; medium-dark-gray.	6.5	133.2
C-27: Ostracode-bearing intramicrudite; faintly tiger-striped near top; brownish-gray.	2.0	131.2
C-26: Algal-mat biomicrite and algal-mat intramicrite; medium-gray.	2.8	128.4
C-25: Disturbed fossiliferous intramicrudite; contains ostracodes and algal layers; medium-dark-gray.	0.6	127.8
C-24: Algal-mat biomicrite intercalated with thin intramicrite bands; contains a few ostracodes; medium-gray; creamy-white weathered surfaces.	3.4	124.4
C-23: Fossiliferous intramicrudite; contains ostracodes, trilobites, and algal layers; exhibits red staining; medium-gray to light-brownish-gray; fucoidal weathering pattern.	6.3	118.1
C-22: Sparse mixed biomicrite; contains ostracodes and algal layers; brownish-gray; weathers to a light-gray.	2.0	116.1
C-21: Dolomitized sparse algal-mat biomicrite; massive appearing unit; medium-dark-gray to brownish-gray.	5.5	110.6
C-20: Dolomitized algal-mat biomicrite; banded; medium-dark-gray.	3.0	107.6
covered:	5.3	102.3
C-19: Dolomitized burrowed algal-mat biomicrite; massive appearing unit; medium-gray.	2.8	99.5
C-18: Dolomitized intramicrite; pinkish-gray.	6.0	93.5
C-17: Dolomitized burrowed micrite and layers and pockets of intramicrite; medium-dark-gray.	6.0	87.5
covered:	3.5	84.0

Description	*Thickness in feet*	*Feet above base*
C-16: Dolomitized intercalated algal-mat biomicrite and fine and coarse intramicrite; banded; brownish-gray.	2.5	81.5
C-15: Dolomitized micrite; medium-gray.	4.0	77.5
covered:	2.8	74.7
C-14: Fossiliferous intramicrudite; contains ostracodes; tiger-striped units; medium-dark-gray.	4.2	70.5
C-13: Dolomitized intramicrite intercalated with dolomitized micrite; banded; medium-gray to brownish-gray.	2.2	68.3
C-12: Dolomitized intramicrite; medium-dark-gray; resembles type Tea Creek lithology.	0.8	67.5
C-11: Dolomitized burrowed and mud-cracked algal-mat biomicrite; banded; medium-dark-gray.	8.4	59.1
C-10: Dolomitized algal-mat intramicrudite; mottled; clasts well-rounded; medium-gray.	2.5	56.6
C-9: Dolomitized algal mat intramicrite; banded; medium-light-gray.	3.8	52.8
covered:	14.0	38.8
C-8: Dolomitized sparse intramicrite; medium-dark-gray.	1.2	37.6
covered:	3.5	34.1
C-7: Dolomitized intramicrite; medium-dark-gray.	2.0	32.1
covered:	11.5	20.6
C-6: Micrite; medium-dark-gray.	0.6	20.0
covered:	1.3	18.7
C-5: Dolomitized micrite with laminations of dolomitized intrasparite; finely layered; brownish-gray.	0.7	18.0
covered:	6.0	12.0
C-4: Intramicrudite; medium-gray to light-brownish-gray.	2.3	9.7
C-3: Micrite; mottled; thin-bedded; medium-dark-gray; fucoidal weathering pattern.	2.0	7.7
C-2: Sparse intramicrite; tiger-striped unit; medium-dark-gray.	6.0	1.7
C-1: Dolomitized intramicrite; finely laminated; light-brownish-gray.	1.7	0.0

BELLEVILLE SECTION

(Lewistown 15-minute quadrange, Pennsylvania, latitude 40°36′30″ N., longitude 77°44′45″ W.)

This locality consists of three separate outcrops. A good exposure of both members of the Bellefonte Dolomite, Coffee Run, and Tea Creek Members, exists in the Union Township quarry. This quarry is situated in the town of Belleville and is entered through the parking lot west of the Belleville bank and through a farmyard towards the west. The quarry is directly south of a small stream, Little Kishacoquillas Creek. The

contact between the Coffee Run and Tea Creek Members is on the east side of the quarry. Samples B-1 through B-5 were collected in the quarry.

The Milroy Member crops out in a small field on the north side of Route 305 west of the town of Belleville. The outcrop begins in a field just west of Little Kishacoquillas Creek and extends westward. The total thickness of strata is approximately 35 feet; samples B-6 through B-13 were collected at this site. It was at this locality that abundant trilobite remains were found.

The Milroy also crops out approximately 250 feet to the west with 18 feet of section exposed on this hillside; samples B-14 through B-19. The contact between the Clover Limestone and the Milroy Member lies buried between this outcrop and the strata which crop out along Route 305 to the west, a distance of 150 feet. Specimen B-20 was collected from the lower portion of the Clover Limestone along Route 305.

Description	*Thickness in feet*	*Feet above base*
LOYSBURG FORMATION		
Clover Member		
B-20: Mixed fossiliferous intramicrudite; contains crinoids, bryozoans, ostracodes, and gastropods; dark-gray.		
covered:		
Milroy Member		
B-19: Dolomitized disturbed algal-mat biomicrite; medium-gray to light-brownish-gray.	4.0	14.0
B-18: Algal-mat biomicrite near base grading up into an intramicrudite; medium-gray.	3.5	10.5
B-17: Dolomitized algal-mat biomicrite; very dense rock; medium- to medium-dark-gray; weathers to a light-brownish-gray.	3.0	7.5
B-16: Ostracode-bearing burrowed dismicrite; thoroughly churned; brownish-gray; fucoidal weathering pattern most likely due to burrowing.	3.0	4.5
B-15: Dolomitized intramicrite; mottled; some portions are finely laminated; medium-gray to brownish-gray.	3.0	1.5
B-14: Disturbed algal-mat intramicrudite; medium-dark-gray to brownish-gray; very finely laminated on weathered surface.	1.5	0.0
covered:		
B-13: Fossiliferous intramicrudite; algal layers intercalated with intramicrite zones; red staining; medium-gray.	4.0	31.3
B-12: Disturbed algal-mat biomicrite and intramicrudite; appears to have burrowed zones; contains abundant trilobite fragments approximately 4 feet above base of unit; also contains ostracodes and brachiopods; prominent tiger-striped unit; medium-dark-gray.	12.0	19.3

Description	*Thickness in feet*	*Feet above base*
B-11: Algal-mat biomicrite; contains some ostracodes; massive appearing unit; medium-light-gray to light-brownish-gray.	2.5	16.8
B-10: Sparse algal-mat biomicrite; prominent tiger-striped unit; medium-dark-gray.	2.0	14.8
B-9: Sparse intrasparite intercalated within a micrite; medium-dark-gray.	5.5	9.3
covered:	1.5	7.8
B-8: Sparse intrasparite intercalated within a micrite; medium-dark-gray to brownish-gray; weathers to a white with algal laminations showing on the weathered surface.	2.0	5.8
B-7: Dolomitized micrite; massive appearing unit; medium-gray; weathers to a creamy-white.	2.5	3.3
B-6: Dolomitized fossiliferous sparse intramicrudite: algal laminations; light-gray to light-brownish-gray.	3.3	0.0
covered:		

BELLEFONTE DOLOMITE

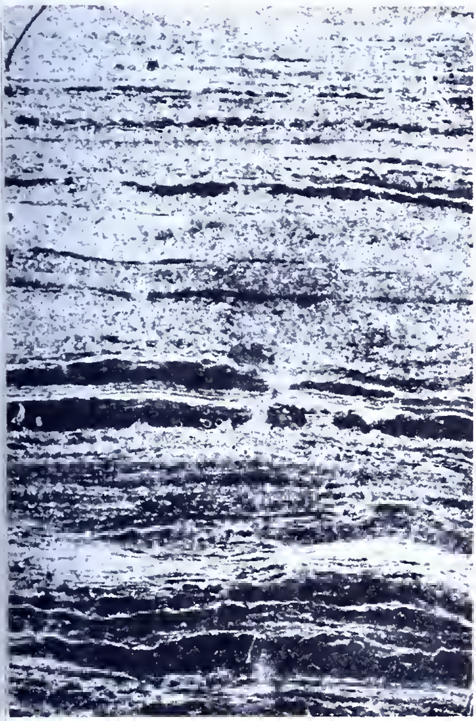
B-5: Dolomitized sparse algal-mat biomicrite; medium-gray.	75.0
B-4: Dolomitized sparse intramicrudite; light-gray.	45.0
B-3: Dolomitized algal-mat biomicrite; medium-gray.	20.0
B-2: Dolomitized sparse intramicrite; medium-dark-gray.	10.0
B-1: Dolomitized intramicrudite; medium-gray.	0.0

PLATE 1.—ACETATE PEELS OF SELECTED ROCK TYPES

Figure 1. **Sample R-43; typical peel of algal mat, exhibits irregular, crenulated layers often disrupted (negative print, X4).**

Figure 2. **Sample S-15; peel of crenulated algal layers overlain by an intramicrudite (negative print, X4).**

Figure 3. **Sample L-74; peel of algal mat exhibiting selective dolomitization of thin algal layers (negative print, X4).**



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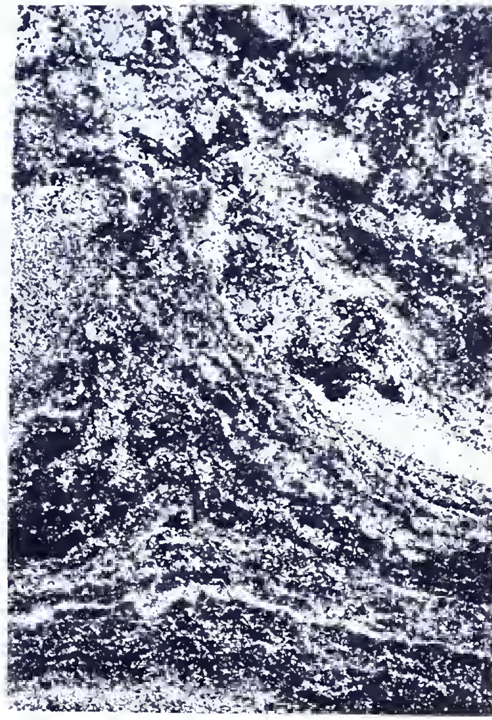

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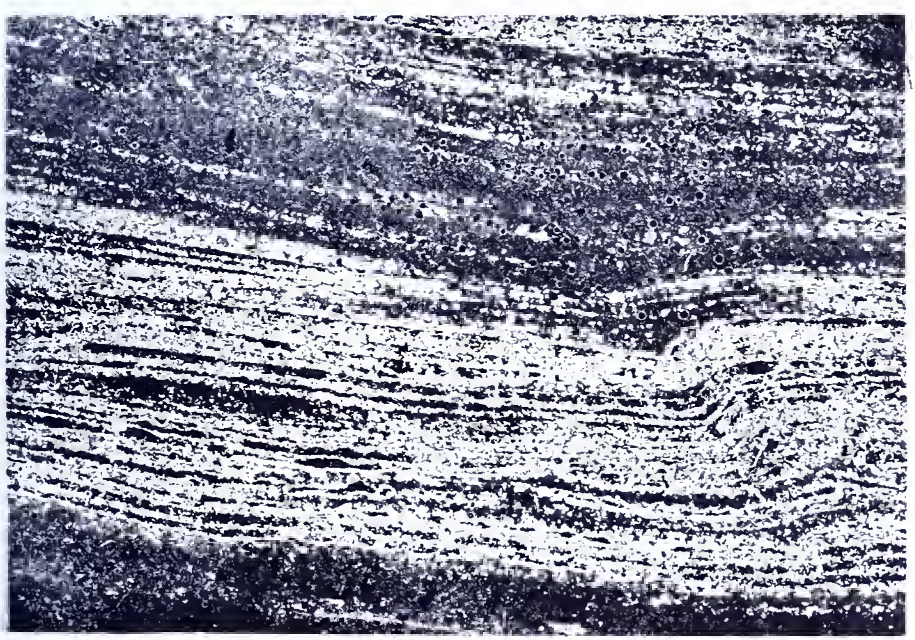

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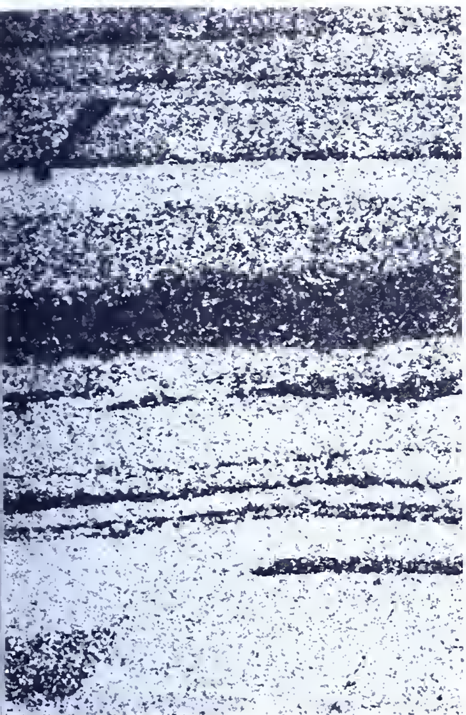
PLATE 2.—ACETATE PEELS OF SELECTED ROCK TYPES

Figure 1. **Sample L-68; peel shows channel, lower left, which has a graded deposit, dark areas are cemented by spar, the rest of the material is micrite; grading is prominent in the center of the photograph (negative print, X4).**

Figure 2. **Sample L-40; an example of the "cloudlike" dolomitization pattern, readily distinguishable burrows in the lower portion of the photograph (negative print, X4).**

Figure 3. **Sample L-32; abundance of shell material, dark patches, in "placerlike" deposit (negative print, X4).**



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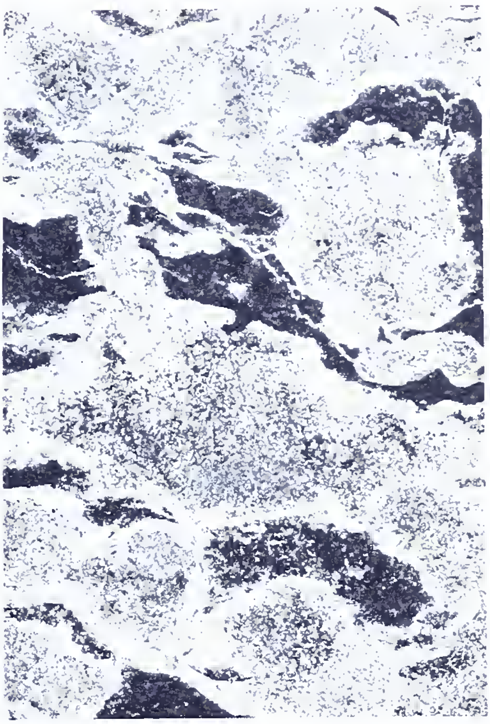

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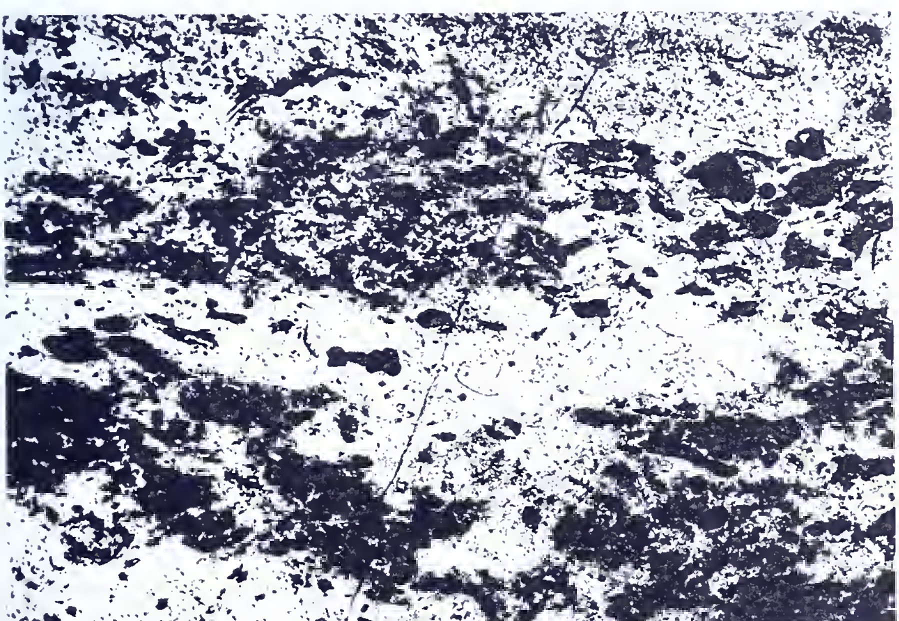

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